SIMPLIFIED

VALVE AND CIRCUIT TESTING

with the

AVODAPTER

and the

AVOMETER

SIMPLIFIED

Valve and Circuit Testing

with the

AvoDapter

and the

AvoMeter

AUTOMATIC COIL WINDER AND ELECTRICAL EQUIPMENT CO. LTD

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The NEW 36-RANGE UNIVERSAL AVOMETER

Patent No. 200977. Other Patents Pending. *Regd. Trade Mark.*

for measuring A.C. and D.C. Current and Voltage, also D.C. Resistance.

B.S. 1st. Grade from 25 to 100~ and within 5% at 5,000~.

Total resistance of instrument :- 200,000 ohms.

D.C. RANGES

CURRENT	VOLTAGE	RESISTANCE
50 microamps to 12 amps.	500 microvolts 1,200 volts.	0.1 ohm to 1 megohm.
*0—12 amps.	*0—1,200 volts	*0—1 megohm
0— 6 ,,	0— 600 ,,	*0—100,000 ohms
*0— 1.2 ,,	*0— 120 ,,	*0— 10,000 ,,
0—600 m.a.	0— 60 ,,	*0— 1,000 ,,
*0—120 ,,	*0— 12 ,,	
0— 60 ,,	0— 6 ,,	
*0— 12 ,,	*0— 1.2 ,,	
0— 6 ,,	0— 600 millivolts	
	*0— 120 ,,	
	0— 60 ,,	

**Indicates the thirteen ranges of the D.C. AvoMeter*

A.C. RANGES

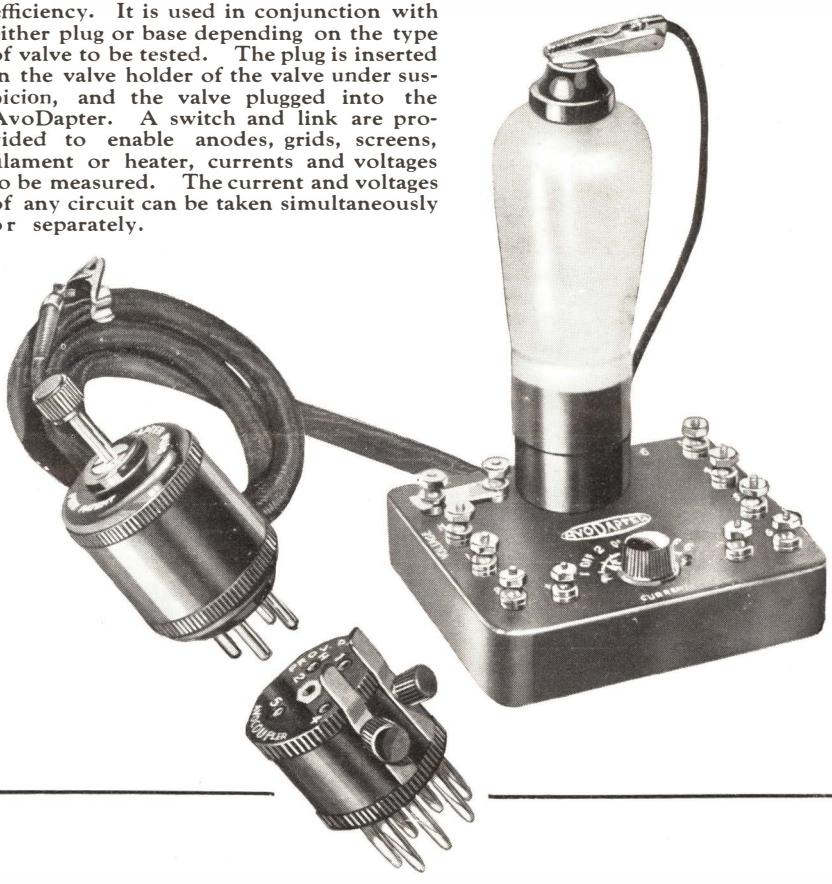
CURRENT	VOLTAGE
500 microamps to 12 amps.	50 millivolts to 1,200 volts.
0—12 amps.	0—1,200 volts
0— 6 ,,	0— 600 ,,
0— 1.2 ,,	0— 480 ,,
0—600 milliamps	0— 240 ,,
0—120 ,,	0— 120 ,,
0— 60 ,,	0— 60 ,,
	0— 12 ,,
	0— 6 ,,

The AvoDapter

Incorporating the new convertible four and five pin plug and the Avo-Coupler for 7-pin valves

(Patent No. 399,193 : other patents pending.)

The AvoDapter consists of a plug (instantly convertible for 4- or 5-pin valves) without loose parts, connected to a testing holder or base, which provides for the taking of voltages and currents in all the valve circuits, with comfort on the bench. The Avo-Coupler is a 5 to 7 pin conversion adapter, which enables the operator to deal with multi-electrode valves also with ease and efficiency. It is used in conjunction with either plug or base depending on the type of valve to be tested. The plug is inserted in the valve holder of the valve under suspicion, and the valve plugged into the AvoDapter. A switch and link are provided to enable anodes, grids, screens, filament or heater, currents and voltages to be measured. The current and voltages of any circuit can be taken simultaneously or separately.



MODERN radio receivers and components are the result of several years' experience of experiment and trial, and have reached that stage when uniformity of production can be depended upon with some degree of certainty. Service men in particular, although handling many different types of sets and valves, are in a position to adopt routine methods of testing for faults, but are, in many cases, hampered in their work by the absence of a convenient method of carrying out their tests. For many years the AvoMeter has been a great favourite by virtue of the ease and rapidity with which this truly universal instrument may be set up to read voltage, current and resistance, but time and temper are often lost by the fact that the measurement of the performance of valves is rendered difficult by the inaccessibility of testing points. This, of course, applies to almost all testing instruments, but the introduction of the AvoDapter and the AvoCoupler has reduced practically every valve test to the simplest possible terms. The application of these instruments is very easy, but, for the benefit of non-technical users, this little booklet has been prepared so that any person of average intelligence, whether technical or not, may undertake the finding of faults with some degree of assurance.

The AvoDapter consists of a valve holder, the connections to the sockets of which may be interrupted by a rotary switch, thus allowing a current meter to be inserted in the various feeds without alteration to the exterior wiring. This switch has seven clearly defined positions, each of which is made positive by the ratchet action of the contacts. To this testing holder is attached a flexible cable, the other end of which terminates in a plug, and as the terminals on the testing base are directly connected to the pins of this plug, voltages applied to the various electrodes of the valve under test may be measured without interfering with the wiring of the receiver in any way.

The AvoDapter plug is instantly convertible for either 4 or 5 pin valves, and its physical dimensions allow it to be used in any type of holder, whether they be flush fitted or of the sunken type now becoming popular. The flexible cable is brought out at an angle on the top of the plug, thus obviating sharp bends and kinking in the cable when used with valve holders in inaccessible positions. There are two small contact studs on the side of the plug which are connected through the cable to terminals on the testing base. These are used in connection with the AvoCoupler for the testing of seven pin valves as will be explained in the text.

The AvoCoupler is a combination of seven pin plug and five pin socket, and its use enables the AvoDapter to be quickly set up for 5 or 7 pin valves. If the valve to be tested has five pins the coupler must be plugged into the testing base (which has a seven pin socket), the plug into the holder on the set vacated by valve, and the valve into the coupler. For testing seven pin valves this procedure is reversed, the valve going directly into the testing base, plug into the coupler, and coupler into valveholder on receiver. When the AvoDapter plug is inserted into the AvoCoupler the small studs on the side of the plug will connect with the spring contacts in juxtaposition on the coupler which will complete the extra circuits required with multi-electrode seven pin valves. These circuits can be broken for current measuring purposes by the insertion of a spade terminal, with connecting lead, under the insulated terminal heads provided, the meter being connected between this lead and the appropriate terminal on base.

All the sockets on the AvoDapter and AvoCoupler have longitudinal splits, and are of the floating type, thus ensuring good contact with split or solid pin valves.

Some of the many applications of the AvoDapter will now be described.

Routine Test of the Valves of a Receiver

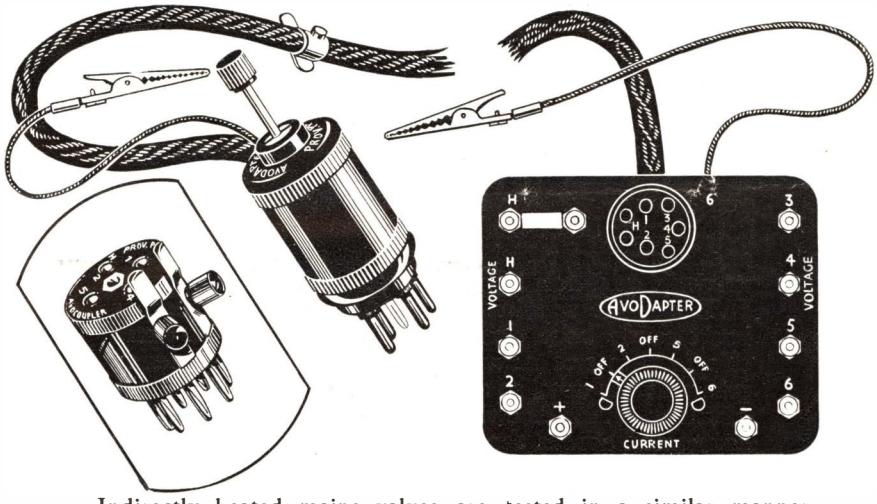
Valves working at Radio Frequencies

These are almost invariably screen grid valves or H.F. Pentodes, either of which may be of the variable-mu type or not, and their cathodes can be either directly or indirectly heated.

With directly heated (battery) valves the procedure is as follows : Remove the valve from the set, and assuming that the AvoCoupler has been plugged into the AvoDapter base, insert valve into coupler. Having pulled up the centre

contact pin, insert the AvoDapter plug in the set and connect the separate clip to the anode lead ; the clip lead from the AvoDapter base is connected to the anode terminal of the valve. If, now, the AvoMeter switch be set to 0.012 amps. D.C. (12 milliamperes full scale) the leads may be connected to the AvoDapter current terminals and, if a variable mu valve is being tested, the grid bias volume control on the set should be set to maximum. Moving the AvoDapter switch to 6 will give anode current ; switching to 5 will give screen current (which may be negative), and grid current, if present, will be indicated with the switch at 1. A return to position 6 should be made and the bias volume control tested for smoothness and continuity. As the control is rotated towards minimum, the anode current will be found to drop rapidly at first, and then more slowly until the minimum position, when the current will approach closely to zero. With ordinary screened grid valves the volume control test is not, of course, carried out. In testing, H.F. Pentodes in no way differ from screen grid valves, and may or may not have variable-mu characteristics. However, not infrequently, they are found with seven pins, and although the foregoing methods still apply, it is necessary to plug them directly into the AvoDapter base, the plug being inserted into the coupler, and thence to valveholder in receiver. This is necessary with all types of seven pin valves, and will be taken for granted in the succeeding text.

If the anode current of the valve under test is low, it may be due to deficient H.T., too much grid bias or loss of emission. The value of H.T. voltage should now be checked. The current switch of the AvoDapter is set to " Off," unless a milliameter is left in circuit to read current while the voltage is read and the negative side of the filament supply determined. This is easily done by connecting the AvoMeter (set to 12 volts D.C.) to the terminals marked " H". If the pointer gives the L.T. reading the polarity is correct and is given by the colour of the leads, negative being black. If the meter kicks back, then the red lead is on the negative terminal. Assuming the right polarity has been established, set the AvoMeter to 1,200 volts D.C., connect the black lead to " H –," when red on 6 will give anode volts, and on 5 screen grid volts. If de-coupling resistors are included in the receiver the reading will be slightly low, but provided that the 1,200 volt range is used, this error can be neglected. Continuity of the grid circuit will be indicated with " AvoMeter " at 12 volts D.C. and leads on " H – " and 1, but grid bias must be measured by direct test across the grid battery.



Indirectly heated mains valves are tested in a similar manner, except that the negative lead of the AvoMeter will, in voltage tests, be connected to terminal 2 of AvoDapter. When these valves have an automatic bias, using for instance the cathode resistance method, an approximation of the difference of potential existing between cathode and grid may be obtained with the AvoMeter set to the highest voltage range, permitting a reasonable reading, and inserted between terminal 2 on the AvoDapter and the remote end of the cathode resistance, which in most cases will be the chassis or earth line.

The link between terminal " H " and the terminal on its immediate right, is particularly useful when testing indirectly heated D.C. and Universal type valves. By opening this link and connecting the AvoMeter (set to 1.2 amps D.C.) between the terminals, the amount of current drawn by all the valves, which in these cases will be connected in series, can be determined.

Frequency changing in superheterodyne receivers is often accomplished with the aid of H.F. Pentodes or Heptodes. With the former, the measurements required are primarily the same as for ordinary H.F. valves, but, in the latter case, it will sometimes be necessary to measure the voltage applied to the oscillator anode. This can be obtained by connecting the AvoMeter (set to 1,200 volts D.C.) between terminals 2 and 4. Current in this circuit may be determined by inserting spade terminal under appropriate spring contact (4) on Avo-Coupler and connecting " AvoMeter " (set to .012 amps D.C.) between remote end of spade lead and terminal 4. Remember that the top cap of a Heptode is the control grid and may show a small negative voltage.

Typical values of voltages applied to and current drawn by screened grid valves are as follows :

	Anode Volts.	Screen Volts.	Anode Current.	Screen Current.	Filament or Heater Current Amps.	Volts.
Battery	120	60–80	1.5–2.5		.1–.2	2–4
,, Var. Mu. ...	120	60–80	2.5	Varies	.1–.2	2–4
Mains A.C.	150–200	60–80	4	from	1	4
,, Var. Mu. A.C.	200	80–100	8	Negative	1	4
,, D.C.	200	80–100	5	to	.25 or .18	16 or 20
,, Var. Mu. D.C.	200	80–100	8	Positive	.25 or .18	16 or 20
,, Universal ...	200	100	3–5	Values	.25 or .18	16 or 20
,, Var. Mu. Univ.	200	100	5–8		.25 or .18	16 or 20
H.F. Pentodes Batt.	120	60–80	2-3		.1 or .2	2
,, ,, A.C.	200	80–100	5		1	4
,, ,, D.C.	200	80–100	5		.25 or .18	16 or 20
,, ,, Univ.	200	80–100	5		.25 or .18	16 or 20
Mains A.C. Heptode	200	100	variable		1	4

The Detector Valve

Nearly all receivers now use leaky grid or power grid detectors, and the only measurements required are the anode volts and the anode current. It is impossible to give typical values of these, as designs vary within wide limits. The valve makers' lists should be consulted to determine the value of anode current which should be passed when the valve in question is being used with the particular H.T. voltage applied. The AvoDapter is used as has already been described, except that the extra clip lead is not now employed unless a screened grid valve is used as a detector. Anode current is obtained with the switch at 5, the AvoMeter being connected across the current terminals, and anode volts are measured at terminals " H " (assuming correct polarity has already been established) and 5. It is important to remember that the true anode current will only be obtained when the set is not tuned in to a station ; preferably the aerial should be disconnected. Furthermore, if the detector valve is oscillating, the anode current will be considerably reduced, generally by as much as 50%. The true state of affairs inside the valve can readily be determined by short-circuiting the grid to earth. If, upon doing this, the anode consumption rises considerably, it can be assumed that the valve was originally in an oscillating condition. With the milliammeter in the anode circuit of the detector, several interesting tests can be made. The smoothness of the reaction control can be tested, for gradual application of reaction ought to result in gradual decrease of anode current until the oscillating point is reached. A sudden transition from maximum current to minimum current shows a poor design of reaction circuit.

Reaction being cut off, and the aerial connected, a station should be tuned in and the anode current should be reduced by 10% to 20% with one H.F. stage, and considerably more with two. A certain amount of thought will enable one to form a very fair opinion as to the merits of design of the receiver under test. Whatever the amount of low frequency amplification before the output valve, " carrier depression " with a power grid detector ought to be about 15% of the steady

anode current in the absence of signals to ensure distortionless rectification, and this will, or ought, to fill the output valve. If the output valve is overloaded on loud signals with this amount of H.F. applied to the detector, then there is too much L.F. amplification. If the output valve would stand more, then there is too little, but it can be said that this is a rare fault, the error being nearly always in the other direction. It may be found that one cannot get at least 10% depression and, assuming that the radio volume control is at maximum, it can be concluded that there is insufficient H.F. amplification of the station being received. This may, of course, be caused by a poor aerial, but if it is possible to overload the output valve and yet have a small carrier depression on the detector, then the design of the set is bad. More than 25% depression will cause detector "wipe out" and double hump tuning will be set up on powerful stations. The radio volume control should be reduced until this disappears. It can be pointed out that the logical conclusion is that, in sets which profess to give high quality reproduction, it is essential that a detector anode current meter be fitted and two volume controls, one for radio frequencies to ensure the correct amount of carrier depression, and one for the L.F. amplifier to make the reproduction as loud or as soft as the occasion may require. If one H.F. valve with an outdoor aerial, or two valves with an indoor aerial are insufficient to give 10% depression on a regional station, one is justified in assuming that the H.F. amplifier is not working efficiently.

Thediode detector has conferred many benefits upon the modern receiver, among which are, distortionless rectification, a simple means of providing automatic volume control, and an input load so small in magnitude that the preceding tuned circuit is but lightly damped. However, as the diode cannot amplify it has been found necessary to employ an intermediate L.F. stage, so that there shall be sufficient grid swing to load the output valve. To conserve space, two diodes, one for rectification, and the other for A.V.C. are usually mounted in the same envelope as the intermediate L.F. valve, and we thus have the familiar duo-diode-triode and duo-diode-pentode, both of which

are seven pin valves and conform to the general method of test. In the D.D. Triode, anode current will be measured with the AvoDapter switch at 5, and voltage between 2 and 5 (if independently heated), " H— " and 5, (if battery operated) while with the D.D. Pentode, screen grid current will be registered at 5, and anode current at 6, and voltages between the appropriate terminals. There is one exception in the D.D. Pentode range which will be mentioned later.

Valves working at Audio Frequencies

The number of types of valves for low frequency amplification is so great that the makers' lists should be consulted for the normal anode current and voltage. In general, the testing of these with the AvoDapter is as has been described, but as the disposition of the pins is not yet quite standardized, care must be taken to see that grid circuits are not opened unnecessarily. A point to notice is in connection with pentodes. Battery types may be found with four pins and side terminal or with five pins and no side terminal. The method of testing for auxiliary voltage and current is slightly different for the two types. In current readings, the AvoMeter is connected to the current terminals, when, with the switch set at 6 for the directly heated 4-pin type, and at 2 for the directly heated 5-pin type, the current drawn by the auxiliary grid is shown. When reading voltage, the AvoMeter is connected to the appropriate voltage terminals, the current switch then being off. The clip lead which goes to the side terminal of pentode valves, when this is present, is numbered 6. The table below shows the connections for measurements necessary with valves working at Audio frequencies. We must assume that negative " H " for battery valves has been previously determined.

Type of Valve.	Anode Current Switch at	Anode Volts Terminals.	Auxiliary Grid Curr. Switch at	Auxiliary Grid Volts Terminals.
		— +		— +
Directly Heated Triode, 4-pin	5	H and 5	—	—
Indirectly Heated Triode, 5-pin	5	2 and 5	—	—
Directly Heated Pentode, 4-pin	5	H and 5	6	H and 6
Directly Heated Pentode, 5-pin	5	H and 5	2	H and 2
Indirectly Heated Pentode, 5-pin	5	2 and 5	6	2 and 6
Indirectly Heated Pentode, 7-pin	5	2 and 5	1	1 and 2

An exception to the foregoing will be in the case of triodes and pentodes of the directly heated type with A.C. filament supply. In this case, the voltage reading will be between the earth line (H.T. — or E.) and 5 for anode volts. For auxiliary screen volts in pentodes, between the earth line and 2 for 5-pin valves, or between the earth line and 6 for sdie terminal types.

Occasionally, a double-diode output pentode is found, and although this may perform the treble function of detection, A.V.C., and power amplification, for testing purposes it must be regarded as an output valve, and treated as such. It is a seven pin valve, and has its control grid situated at the top cap. With the AvoDapter switch at 5 the screen current is read, but for anode current, it will be necessary to insert spade terminal under appropriate spring contact (3) on AvoCoupler, and connect AvoMeter (set to .120 amps. D.C.) between remote end of spade lead and terminal 3 on AvoDapter.

The grid circuit of output valves can be tested for continuity by connecting the AvoMeter, set for volts, to terminals " H " (or 2 with indirectly heated valves) and 1, but grid bias must be measured at the source of supply, as the presence of a transformer or grid leak in the grid circuit will cause incorrect readings.

Rectifying Valves

The D.C. voltage output of half and full wave rectifying valves may be tested by inserting the valve in the AvoDapter and fitting the AvoDapter plug to the valve holder. The positive lead of the AvoMeter must be connected to the centre tap of the filament winding of the power transformer, and the voltage between the anode or anodes and the filament can be read by connecting the negative meter lead to terminals 1 or 5 of the AvoDapter.

In the case of valves of all types, the filament or heater voltage can be measured at terminals " H " and " H " but with A.C. mains valves, an A.C. voltmeter or Universal AvoMeter is required for this purpose.

Rapid Determination of Mutual Conductance, Anode Resistance and Amplification Factor of any Valve.

The thoughtful and ingenious user will find many other applications of the AvoDapter which will help him in his work. The following is given as an example, and will be found of great value in determining whether a suspected valve is good or not. The method is given for triodes, but the same principles can be used for tetrodes and pentodes. The standard values of bias and anode voltage are given in the makers' lists, and must be used in the tests. For triodes proceed as follows :—

The valve for test is inserted in AvoDapter Holder, the plug being laid on bench and not connected to any other apparatus. An L.T. accumulator of appropriate voltage is connected to terminals " H " and " H " (note which is negative). A grid bias battery of $1\frac{1}{2}$ volts should be measured as accurately as possible. Connect terminal 1 to " H --" if a battery valve or to 2 if an indirectly heated valve. Now connect 100-volt battery, the positive to terminal 5 and the negative to L.T.—, the switch being at " off," and measure anode voltage. Connect AvoMeter to current terminals and turning switch to 5, measure anode current.

Suppose the anode volts and current are 100 volts and 27 mA. respectively. Open joint between 1 and 2 (or —"H"), and insert grid bias battery, the negative side going to 1, and note new anode current. Suppose the current has dropped to 21 mA. If the voltage of the G.B. battery is exactly $1\frac{1}{2}$, the mutual conductance can be found by the formula :—

$$\text{Mutual Conductance (mA. per V.)} = \frac{\text{Change in anode current (mA.)}}{\text{Change in grid volts.}}$$

$$= \frac{6}{1\frac{1}{2}} = 4 \text{ milliamps per volt.}$$

Now remove grid battery and reconnecting 1 to 2 (or —" H "), according to type of valve, note anode current which will presumably still be 27 mA. the voltage remaining at 100 V. Now drop the H.T. voltage about 10 volts, the new voltage being measured accurately with switch at " off " position, and again note the anode current as before. Suppose the change in voltages is 10 exactly, the new current being 24 mA., the anode resistance can be determined from the formula :—

$$\text{Anode resistance (ohms)} = \frac{\text{Change in anode volts} \times 1000}{\text{Change in anode current (mA.)}}$$

$$= \frac{10 \times 1000}{3} = 3300 \text{ ohms. (approx.)}$$

$$\text{Amplification Factor} = \frac{\text{Mutual Conductance} \times \text{Anode Resistance}}{1000}$$

$$= \frac{4 \times 3300}{1000} = 13 \text{ (approx.)}$$

It is important that these tests be carried out as expeditiously as possible, as otherwise excessive anode current caused through absence of grid bias might damage the valve. One final reminder, unless the milliammeter be connected to the current terminals, always set switch to " off."

The AVO DAPTER

PRICE COMPLETE

with AvoDapter Plug, AvoCoupler and Testing Base as illustrated on page 3.

25/-

For those already possessing testing equipment, or wishing to make their own, the Avo-Dapter Patent Convertible Plug can be supplied with a six-way lead for

7/6

The NEW 36-RANGE UNIVERSAL AVOMETER

This new Avometer gives readings in any of 36 different ranges of D.C. Amps, Volts and Ohms, and A.C. Amps and Volts — without external shunts, multipliers or transformers.

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